Technical Support Document: Toxicology Clandestine Drug Labs: Methamphetamine

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SODIUM

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Introduction

The clandestine synthesis of methamphetamine (meth) and other illegal drugs is a growing public health and environmental concern. For every pound of meth synthesized there are six or more pounds of hazardous materials or chemicals produced. These are often left on the premises, dumped down local septic systems, or illegally dumped in backyards, open spaces, in ditches along roadways or down municipal sewer systems. In addition to concerns for peace officer safety and health, there is increasing concern about potential health impacts on the public and on unknowing inhabitants, including children and the elderly, who subsequently occupy dwellings where illegal drug labs have been located.

The Office of Environmental Health Hazard Assessment (OEHHA), in cooperation with the Department of Toxic Substances Control (DTSC), has been charged with assisting in identifying and characterizing chemicals used or produced in the illegal manufacturing of methamphetamine, which pose the greatest potential human health concerns. To address in part this growing environmental problem and the need for public health and safety professionals to make appropriate risk management decisions for the remediation of former methamphetamine laboratory sites, OEHHA has developed two types of chemical-specific information documents.

The first set, technical support documents (TSDs), are referenced, multi-page publications, which contain important health and safety data, exposure limits, and key information for recognizing chemicals used or produced during the manufacturing of methamphetamine. These documents will likely be most helpful to health and safety officers, industrial hygienists, or others interested in more detailed toxicological information. The second set, two-page fact sheets, contain much of the same information as the corresponding TSDs; however, the details are presented in a more succinct, graphical format. The fact sheets will be helpful to individuals, including the public, who want to be able to quickly recognize potential chemicals of concern found in illegal methamphetamine labs in order to avoid inadvertent exposures and resulting health impacts.

For more information or to obtain copies of these and other documents, contact:

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I. Chemical Name

A. SODIUM (Na)

B. Synonyms

Sodium metal, elemental sodium.

II. Role in Clandestine Drug Synthesis: Methamphetamine

Elemental sodium is used as a catalyst in the ammonia/alkali metal method (Nazi method) to synthesize methamphetamine from ephedrine. In clandestine methamphetamine labs, sodium may be produced by electrolysis of sodium hydroxide (lye). A common source of sodium hydroxide is Red Devil® drain cleaner.

III. Chemical Description

A. Appearance

Sodium is a soft, silvery, malleable solid that can readily be cut with a knife. Lustrous when freshly cut, it rapidly tarnishes to a dull gray in dry air (Cotton & Wilkinson, 1966; HSDB, 2001). If submerged in an organic solvent, sodium may develop an outer crust of sodium oxide. Eventually, the outer crust appears sponge-like. Lumps of sodium are often stored in an organic solvent, such as mineral spirits or kerosene, or sealed in a metal container (Turkington, 2000). Sodium dissolves in liquid anhydrous ammonia, forming a blue solution when dilute. At higher concentrations of sodium, the solutions are copper colored and have a metallic luster (Cotton & Wilkinson, 1966).

B. Taste

Not applicable.

C. Odor

Not applicable.

D. Odor Threshold

Not applicable.

E. Irritancy Threshold

Not applicable.

F. Odor Safety Class

Not applicable.

G. Vapor Density

Not applicable.

H. Vapor Pressure

Not applicable.

IV. Containers and Packaging

A. Commercial Products

Sodium is available from commercial labs in the form of ingots, lumps, or sticks. It is packaged in a container of mineral spirits or kerosene, or packaged under nitrogen. It is also sold as 30-40% dispersions in toluene, mineral spirits, light oil, or paraffin wax (Aldrich, 2000). Operators of clandestine laboratories may produce “homemade” sodium by electrolysis of sodium hydroxide. The most common commercial source of sodium hydroxide is Red Devil® lye.

B. Pharmaceutical Use

There are no pharmaceutical uses of elemental sodium (USP, 1998).

V. Chemical Hazards

A. Reactivity

Sodium reacts vigorously with water to form sodium hydroxide (NaOH) and hydrogen gas (H_2), which are caustic and flammable, respectively. The reaction generates considerable heat, melting the sodium and frequently igniting the hydrogen gas. Contact with air also should be avoided, because moisture in air reacts rapidly with sodium, forming hydrogen gas and sodium hydroxide. Reaction of sodium with dilute acids is about as vigorous as the reaction of sodium with water (Lemke & Markant, 1995). Sodium reacts explosively with dilute aqueous sulfuric acid (HSDB, 2001), and with many organic compounds, especially those containing oxygen, nitrogen, sulfur, and halogens (fluorine, chlorine, and bromine). Organic compounds containing carboxyl (-COOH) or hydroxyl (-OH) groups also may react with sodium. The reactions are violent in many cases. Sodium may react with <u>un</u>saturated hydrocarbons, adding at double bonds or causing polymerization. Pure, dry, <u>saturated</u> hydrocarbons (for example, mineral oil) do <u>not</u> react with sodium, even at elevated temperatures. Toluene and xylene do not react with sodium. Reactions of sodium are accelerated by dispersion, which increases the exposed surface area (Lemke & Markant, 1995). In general, finely divided sodium reacts much more quickly and vigorously than large pieces of sodium.

B. Flammability

Sodium ignites spontaneously if heated to temperatures above 120°C (250°F). Finely divided sodium may ignite at much lower temperatures. Since sodium melts at 98°C, transition from a solid to a liquid is an indication that sodium is approaching auto-ignition temperatures. Combustion of sodium produces sodium oxide smoke, which is hazardous and highly irritating (Lemke & Markant, 1995).

C. Chemical Incompatibilities

Sodium reacts explosively with water (HSDB, 2001). For this reason, contacting or mixing sodium with dilute aqueous solutions (e.g., aqueous ammonia or dilute acids) should be avoided. Sodium may react violently with a number of organic compounds, especially those containing oxygen, nitrogen, sulfur, halogens (fluorine, chlorine, and bromine), and compounds containing carboxyl or hydroxyl groups (Lemke & Markant, 1995).

VI. Health Hazards

A. General

Inhalation is not a potential route of exposure to sodium. Skin contact and, potentially, inadvertent ingestion of small amounts of sodium appear to be the only complete routes of exposure. Many of the health hazards of metallic sodium result from its extremely vigorous, and potentially explosive, reaction with water. This reaction generates heat, which may produce thermal burns; caustic sodium hydroxide; and flammable hydrogen. On contact with water or moisture, sodium produces sodium hydroxide (NaOH), a strongly corrosive chemical and a powerful irritant. Since moisture is generally present in air, on the skin, in the eyes, and in the mouth, sodium has the potential to cause severe burns and permanent damage to any tissue with which it comes into contact. Since sodium hydroxide is neutralized by contact with tissue and other organic materials, it does not produce systemic toxicity, i.e., it does not cause adverse effects at sites distant from the point of contact (HSDB, 2001).

B. Acute Effects

Acute effects, resulting from short-term exposure to relatively small amounts of elemental sodium, include irritation and burning of the skin, eyes, and mouth. Ingested sodium will react immediately with saliva to form sodium hydroxide, which can burn the inside of the mouth. Swallowing sodium hydroxide will cause abdominal pain and vomiting. Sodium hydroxide may also cause perforation of the gastrointestinal tract and shock; these effects may not become apparent until several hours after ingestion. Eye contact initially will cause burning and could cause permanent eye damage. It may not be possible to ascertain the full severity of damage to the eyes for up to seventy-two hours following exposure (ATSDR, 2000).

C. Chronic Effects

Elemental sodium is extremely reactive, forming sodium hydroxide on contact with moisture. Any chronic effects (resulting from long-term exposure) would be attributable to the corrosive nature of sodium hydroxide. Repeated skin contact with sodium hydroxide may cause dermatitis (ATSDR, 2000).

D. Skin Contact

Direct contact with sodium can cause deep, serious burns from reaction of sodium with moisture present on the skin and subsequent formation of sodium hydroxide, which is extremely caustic (Lemke & Markant, 1995). The heat generated by this reaction can also produce thermal burns. Irritation may become apparent within minutes of exposure to sodium, depending on the amount of moisture on the skin. Characteristically, burns produced by sodium hydroxide appear soft and moist, and are very painful. Less severe exposures will result in inflammation, redness, and swelling. Short-term contact with small amounts of sodium, followed by rapid recovery, is not likely to cause delayed or long-term effects (ATSDR, 2000). Fatalities have occurred following accidental contact with finely divided sodium dispersed in an inert hydrocarbon solvent such as mineral oil or toluene (Lemke & Markant, 1995).

E. Eye Contact

Upon contact with the eyes, sodium reacts with moisture to form sodium hydroxide, which is extremely caustic and can cause blindness (Lemke & Markant, 1995). The heat generated by this reaction can also produce thermal burns. Sodium hydroxide can hydrolyze proteins in the eyes, causing severe eye damage. Formation of surface lesions, destruction of cells, inflammation, and opacification of the cornea may follow. Ulcerations may progress for several days following exposure. Potential outcomes include cataracts, glaucoma, adhesion of the eyelid to the cornea, blindness, and eye loss (ATSDR, 2000).

F. Inhalation

Inhalation is not a typical route of exposure. If inhalation of sodium metal occurs, it is expected that acute effects would include reaction with moisture in the airways to form sodium hydroxide, which would produce thermal and chemical burns.

G. Ingestion

Once ingested, sodium will react vigorously with saliva in the mouth and esophagus to produce sodium hydroxide, which is caustic. This reaction may result in thermal and chemical burns of the mouth, esophagus, and stomach (if a sufficient amount is ingested). The upper airways may also be involved. Symptoms of serious injury to the esophagus include stridor (a harsh sound heard on inhalation caused by air passing through constricted airways), vomiting, drooling, and abdominal pain (HSDB, 2001).

H. Predisposing Conditions

Persons with pre-existing eye or skin disease may be more sensitive to the effects of sodium exposure.

I. Special Concerns for Children

Children may be more susceptible to the adverse effects of ingested sodium. In children, gastric acid is not sufficiently strong or present in sufficient quantity to neutralize even small amounts of a strongly alkaline compound. In addition, children may not recognize the danger associated with chemical exposure and may therefore be more susceptible to accidental and/or purposeful exposures.

VII. First Aid

A. Eyes

Flush eyes with plenty of water for at least fifteen minutes, occasionally lifting eyelids. Get medical attention immediately (Mallinckrodt, 1997).

B. Skin

Remove contaminated clothing and shoes, and wipe off any excess material from skin. Flush skin with plenty of water for at least fifteen minutes. Thoroughly wash clothing and shoes before re-use. Get medical attention immediately (Mallinckrodt, 1997).

C. Ingestion

Do not induce vomiting, but give plenty of water. Do not give anything to an unconscious person. Get medical attention immediately (Mallinckrodt, 1997).

D. Inhalation

Immediately remove victim to fresh air. If victim is not breathing, give artificial respiration, and if victim has difficulty breathing, give oxygen. Keep victim in a half upright position. Get medical attention immediately (Mallinckrodt, 1997).

VIII. Standards for Inhalation Exposure

A. Occupational Exposure Limits (NIOSH, 1997; ACGIH, 1994)

1. Ceiling Limit (C) (not to be exceeded at any time): Not established.
2. Short-Term Exposure Limit (STEL or ST): Not established.
3. 8-Hour Time Weighted Average (TWA): Not established.
4. 10-Hour Time Weighted Average (TWA): Not established.
5. Immediately Dangerous to Life & Health (IDLH): Not established.

Important Definitions Follow:

Ceiling Limit (C) is a concentration that must not be exceeded during any part of the workday.

Short-Term Exposure Limit (STEL or ST) is a 15-minute time-weighted average concentration that should not be exceeded during any part of the workday.

8-Hour Time Weighted Average (8-hour TWA) concentration is an exposure standard that must not be exceeded during any 8-hour work shift of a 40-hour workweek. 8-Hour TWA exposure standards established by the Occupational Safety and Health Administration (OSHA) are called Permissible Exposure Limits (PELs). 8-Hour TWA exposure standards established by the American Conference of Governmental Industrial Hygienists (ACGIH) are called Threshold Limit Values (TLVs).

10-Hour Time Weighted Average (10-hour TWA) concentration is an exposure standard that must not be exceeded during a 10-hour workday of a 40-hour workweek. 10-Hour TWA exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH) are called Recommended Exposure Limits (RELs).

Immediately Dangerous to Life & Health (IDLH) defines a concentration which poses a threat of death or immediate or delayed permanent health effects, or is likely to prevent escape from such an environment in the event of failure of respiratory protection equipment. IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH).

“Skin” notation (NIOSH): significant uptake may occur as a result of skin contact. Therefore, appropriate personal protective clothing should be worn to prevent dermal exposure.

B. Emergency Response Planning Guidelines (1 hour or less) (AIHA, 2002)

1. ERPG-1 (protective against mild, transient effects): Not established.
2. ERPG-2 (protective against serious adverse effects): Not established.
3. ERPG-3 (protective against life-threatening effects): Not established.

Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association (AIHA) to assist in planning and preparation for catastrophic accidental chemical releases. ERPGs allow emergency response planners to estimate the consequences of large-scale chemical releases on human health, and evaluate the effectiveness of prevention strategies and response capabilities. ERPGs assume that the duration of exposure is one hour or less. They are not intended to be used as limits for routine operations and are not legally enforceable.

Definitions for the three ERPG levels are:

ERPG-1: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

C. Acute Reference Exposure Level (1-hour exposure) (OEHHA, 1999)

Level protective against mild adverse effects: Not established.

D. Chronic Reference Exposure Level (multiple years) (OEHHA, 2002)

Level protective of adverse health effects: Not established.

Reference Exposure Levels (RELs) are developed by the California EPA's Office of Environmental Health Hazard Assessment (OEHHA). A REL is a concentration at or below which no adverse health effects are anticipated, even in the most sensitive members of the general population (for example, persons with pre-existing respiratory disease). RELs incorporate uncertainty factors to account for information gaps and uncertainties in the toxicological data. Therefore, exceeding a REL does not necessarily indicate an adverse health impact will occur in an exposed population. Acute RELs are based on an assumption that the duration of exposure is one hour or less. Chronic RELs are intended to be protective for individuals exposed continuously over at least a significant fraction of a lifetime (defined as 12 years).

E. Chronic Reference Concentration (lifetime exposure) (IRIS, 2003)

Level protective of adverse health effects: Not established.

IX. Environmental Contamination Concerns

Elemental sodium reacts violently with water and organic compounds, and does not persist in the environment. Only small amounts of elemental sodium are needed for methamphetamine synthesis. Wastes generated by a clandestine methamphetamine lab will not contain sufficient sodium to result in significant contamination of air, soil, surface water, or groundwater.

A. Surface Water

Due to its explosive reactivity with water, discharge of elemental sodium to surface water will not result in contamination.

B. Groundwater

Elemental sodium is reactive with water and organic compounds. Discharge to soil or directly to groundwater will not result in contamination of groundwater.

C. Drinking Water

Elemental sodium reacts violently with water and will not be present in drinking water.

Suggested No Adverse Response Level (NAS, 1980): Not established.

Preliminary Remediation Goal for Tap Water (U.S. EPA, 2002 Region IX): Not established.

D. Soil

Elemental sodium reacts violently with water and organic compounds, and does not persist in the environment. Only small amounts of elemental sodium are needed for methamphetamine synthesis. Wastes generated by a clandestine methamphetamine lab will not contain sufficient sodium to result in significant contamination of soil.

Preliminary Remediation Goal for Residential Soil (U.S. EPA, 2002 Region IX): Not established.

E. Air

Elemental sodium reacts quickly with airborne water vapor and does not persist in the atmosphere.

Preliminary Remediation Goals for Ambient Air (U.S. EPA, 2002 Region IX): Not established.

F. Indoor Surface Contamination

Sodium reacts quickly with airborne water vapor to form sodium hydroxide, which is highly corrosive. Pieces of sodium may form an outer surface layer of solid sodium hydroxide and can remain very reactive and hazardous (Lemke & Markant, 1995). As a result of sodium hydroxide formation, corrosion and destruction of surfaces may be apparent in areas where sodium is spilled. If accessible surfaces are contaminated with sodium and sodium hydroxide, probable routes of exposure include direct skin contact and ingestion resulting from hand-to-mouth activity.

X. Personal Protective Equipment

Wear a full facepiece, positive pressure, air-supplied respirator and chemical safety goggles. Wear impervious clothing, i.e., boots, gloves, and coveralls, to prevent skin contact (Mallinckrodt, 1997).

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